

Attorney's Docket No. 1-11957

PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re application of: Kenneth M. Fyles and Helen L. McPhail

Serial No.: 08 / 190,883

Group No.: 1108

Filed: February 3, 1994

Examiner:

For: GLASS COMPOSITIONS

TRANSMITTAL OF CERTIFIED COPIES

Attached please find the certified copies of the foreign applications from which priorities are claimed for this case:

Country: United Kingdom

Application Number: 9302186.3

Filing Date: February 4, 1993

Country:

Application Number:

Filing Date:

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Reg. No. 19,066

SIGNATURE OF ATTORNEY

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NOTE: The claim to priority need be in no special form and may be made by the attorney or agent if the foreign application is referred to in the oath or declaration as required by § 1.63.

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Dated 22nd April 1994

PC1

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-4 FEB 1993

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Your reference 4412F/ACH

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9302186.3

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Rule 16 of the Patents Rules 1990 is the main rule governing the completion and filing of this form.

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The  
Patent  
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**Request for grant of a  
Patent**

**Form 1/77**

**Patents Act 1977**

**1 Title of invention**

1 Please give the title of the invention **NEUTRAL COLOURED GLASSES**

**2 Applicant's details**

☐ **First or only applicant**

2a If you are applying as a corporate body please give:

Corporate name **PILKINGTON PLC**

Country (and State of incorporation, if appropriate) **UNITED KINGDOM**

2b If you are applying as an individual or one of a partnership please give in full:

Surname

Forenames

2c In all cases, please give the following details:

Address **PRESCOT ROAD  
ST HELENS  
MERSEYSIDE**

UK postcode **WA10 3TT**  
(if applicable)

Country **UNITED KINGDOM**

ADP number  
(if known)

**660449001 JG.**

2d, 2e and 2f: If there are further applicants please provide details on a separate sheet of paper.

☐ Second applicant (if any)

2d If you are applying as a corporate body please give:

Corporate name

Country (and State  
of incorporation, if  
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2e If you are applying as an individual or one of a partnership please give in:

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① If you are declaring  
PCT Application please  
the country and e  
code (for example, C  
api)

② An address for service in the  
United Kingdom must be supplied

Please mark correct box

Form SI/77-18/1/94

③ Address for service details

3a Have you appointed an agent to deal with your application?

Yes ☒ No ☐ go to 3b

please give details below

Agent's name MICHAEL JOHN LEE Page White + Farrer

Agent's address ~~GROUP PATENTS DEPARTMENT, PILKINGTON-  
TECHNOLOGY CENTRE, PILKINGTON PLC, HALL LANE,  
LATHOM, ORMSKIRK, LANCASHIRE~~

54 Daughay Street  
LONDON

Postcode ~~L40 5UF~~

WC1N 2LS

Agent's ADP

number 1255003 ~~14025235002 JC~~

Please give the  
format, for exa

If you have appointed an agent, all  
correspondence concerning your  
application will be sent to the agent's  
United Kingdom address.

3b If you have not appointed an agent please give a name and address in the  
United Kingdom to which all correspondence will be sent:

Name

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4 Agent's or  
applicant's reference number (if applicable) 4412F/ACH

5 Are you claiming that this application be treated as having been filed on the date of filing of an earlier application?

Yes ☐ No ☒ **→ go to 6**

**please give details below**

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 filing date

(day      month      year)

☐ and the Section of the Patents Act 1977 under which you are claiming:

15(4) (Divisional) ☐ 8(3) ☐ 12(6) ☐ 37(4) ☐

6 If you are declaring priority from previous application(s), please give:

Country of filing

Priority application number  
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Filing date  
(day, month, year)

**6** If you are declaring priority from a PCT Application please enter 'PCT' as the country and enter the country code (for example, GB) as part of the application number.

Please give the date in all number format, for example, 31/05/90 for 31 May 1990.

- 7 The answer must be 'No' if:
- any applicant is not an inventor
  - there is an inventor who is not an applicant, or
  - any applicant is a corporate body.

8 Please supply duplicates of claim(s), abstract, description and drawing(s).

Please mark correct box(es)

- 9 You or your appointed agent (see Rule 90 of the Patents Rules 1990) must sign this request.

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A completed fee sheet should preferably accompany the fee.

## 7 Inventorship

7 Are you (the applicant or applicants) the sole inventor or the joint in

Please mark correct box

Yes ☐

No ☒

A Statement of Inventorship on Patents Form 7/77 will need to be filed (see Rule 15).

## 8 Checklist

8a Please fill in the number of sheets for each of the following types of document contained in this application.

Continuation sheets for this Patents Form 1/77

-

Claim(s)

3

Description

14

Abstract

-

Drawing(s)

1

8b Which of the following documents also accompanies the application?

Priority documents (please state how many)

-

Translation(s) of Priority documents (please state how many)

-

Patents Form 7/77 - Statement of Inventorship and Right to Grant (please state how many)

-

Patents Form 9/77 - Preliminary Examination/Search

-

Patents Form 10/77 - Request for Substantive Examination

-

## 9 Request

I/We request the grant of a patent on the basis of this application.

Signed

*Michael John Lee*

Date

3/2/93

(day month year)

MICHAEL JOHN LEE (Agent for the Applicants)

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SPECS/MH/B785TVJ

Neutral Coloured Glasses

The present invention relates to infra red (IR) and ultra violet (UV) absorbing soda lime silica glasses for use in glazing, more particularly it relates to windows of a neutral tint made of such glasses, particularly for vehicles including motor cars.

Special glasses have been developed for use in vehicles with a low level of direct solar heat transmission (DSHT) and ultra violet transmission (UVT) so as to reduce the problems caused by excessive heating within the vehicle on sunny days, and to protect the interior furnishings of the car from the degradation caused by ultra violet radiation. Glasses with good infra red absorption are usually produced by reducing iron present in the glass to the ferrous state or by adding copper. Such materials give glasses a blue colour. The materials added to achieve good ultra violet radiation absorption are  $\text{Fe}^{3+}$ , Ce, Ti or V. The quantities added to cause the desired level of absorption are such as to tend to colour the glass yellow. The combination in the same glass of both good UV and good IR absorption gives glasses whose colour is either green or blue. This means that when the colour of the glasses is defined by the CIELAB system, the commercial glasses in 4 mm thickness which have greater than 60% transmission are found to be either very green  $-a^*>8$  or very blue  $-b^*>7$ .

Proposals have been made to produce vehicle glazing with good

protection against IR and UV radiation in grey or bronze, but the proposed glasses tend to have a greenish yellow tinge. Thus in, for example, French 2.672,587, the dominant wavelength ( $\lambda_D$ ) of the glasses exemplified varies from 571 to 580 nm, and the colour purity is in the range 4.4 to 15.9% indicating a greenish yellow tinge. A commercial neutral grey glass, ANTISUN (ANTISUN is a trade mark of the Pilkington Group) Grey, available in commerce from Pilkington Glass Limited of St. Helens, England, has a dominant wavelength of 454 and a colour purity of 2.1% in a thickness of 4 mms.

We have identified a requirement for glasses with a neutral tint such that, in the CIELAB system, they have a colour co-ordinate range  $a^*$  from -6 to +5,  $b^*$  from -5 to +5, at visible transmissions above 60% and  $a^*$  -12 to +5,  $b^*$  -5 to +10 below 60% visible transmissions (hereinafter referred to as a neutral tint as herein defined)..

We have found that glasses with a neutral tint free from any dominance in the range 570 nm to 580 nm, and with visible light transmissions greater than 32% (at a thickness of 4 mm), can be formed with a direct solar heat transmission which is at least 7 percentage points (preferably 10 percentage points) less than the % transmission of visible light by using a specified total iron content, a specified minimum FeO content and neutralising the resulting green or blue tint with one or more of Se,  $Co_3O_4$ ,  $Nd_2O_3$ , NiO and MnO. The glasses have a dominant wavelength which is



preferably less than 570. The colour purity for a glass thickness of 4 mm. is preferably not greater than 4 and especially less than 2, (especially when the dominant wavelength is above 570 nm).

Our invention is based on the surprising discovery that the incorporation of relatively large amounts of other specified colouring agents compensates for the green colour arising from the presence of infra red and ultra violet radiation absorbing components, but that such amounts can be incorporated at the levels required without causing an unacceptable reduction in light transmission.

French Patent Specification 2,672,587 at page 5 lines 32 to 35 points out that both CoO and NiO reduce visible light transmission without contributing to either the absorption of ultra violet or infra red radiation, and that it is preferable not to add these components. An upper limit of 0.005% is suggested for CoO but the highest CoO content exemplified is .0010%, supporting the teaching in the specification that these materials should not be used and, if they are, should be present only in limited quantities.

In French Patent 2,672,587, the quantity of Se used in the examples tends to be of the same order or greater than the amount of tinting agent except for one example, example 9, where the  $\text{Fe}_2\text{O}_3$  content is low at 0.178 and the colour purity has a high numerical value 9.6, indicating a substantial departure from a neutral appearance for a 4 mm glass of transmission greater than

60%. We have found it necessary to limit the amount of Se so that it is much less than the other tinting agents.

The field of tinted glasses is one in which relatively small changes can produce major changes in tint. As one patentee has said, it is like a hunt for a needle in a haystack. Wide ranges disclosed in prior patents can encompass many possibilities, and it is only the teaching of the specific examples that can be relied on as identifying how particular tints associated with particular ranges of absorption of infra red and ultra violet radiation can be obtained. It is clear that in French Patent 2,672,587, the correct balance of components to achieve a neutral tint free of unacceptable dominance at wavelengths above 570 nm has not been taught. In attempting to get relatively low DSHT, French patent uses high levels of FeO and clearly it has not been recognised, as has been discovered in the present invention, that this can be balanced by addition of tinting agents without an unacceptable loss in visible light transmission.

According to the invention, there is provided, an IR and UV absorbing soda lime silica glass of a neutral tint as herein defined having a ferrous iron content:

$$\% \text{ by weight FeO} \geq 0.007 + \frac{(\text{Optical Density} - 0.036)}{2.3}$$

and a total iron content expressed as  $\text{Fe}_2\text{O}_3$  in the range 0.25-1.75% by weight, the glass having been tinted to a neutral colour by one or more of Se,  $\text{Co}_3\text{O}_4$ ,  $\text{Nd}_2\text{O}_3$ , NiO and MnO, the glass having, in 4 mm thickness, a visible light transmission of at

least 32%, a UV transmission preferably less than 25%, and a direct solar heat transmission at least 7 percentage points (preferably 10 percentage points) below the visible light transmission, and having a dominant wavelength preferably less than 570 nm; provided that, when the dominant wavelength is above 570 nm and the visible light transmission is greater than 60%, the colour purity is not greater than 4, and preferably less than 2, and that when Se is present, at least one other colourant selected from  $\text{Co}_3\text{O}_4$ ,  $\text{Nd}_2\text{O}_3$ ,  $\text{NiO}$  and  $\text{MnO}$  is present in an amount by weight at least 1.5 times the amount of Se present, preferably 2 times as much.

The quantity of Se is preferably kept as low as is compatible with getting a satisfactory neutral colour. We find it possible to operate satisfactorily at less than 5 ppm Se at visible transmissions greater than 60%.

For the purpose of the present specification and claims, references to visible light transmission are to light transmission (LT) measured using CIE Illuminant A; references to UVT are reference to transmissions measured in accordance with the international ISO 9050 standard over the wavelength range 280 to 380 nm; references to direct solar heat transmission (DSHT) are references to solar heat transmission integrated over the wavelength range 350 to 2100 nm according to the relative solar spectral distribution Parry Moon for air mass 2; total solar heat transmission (TSHT) equals DSHT plus the solar heat that is absorbed and reradiated in the forward direction.

Figure 1 is a plot of transmission against FeO content for a series of grey glasses showing the improvement in properties that can be achieved, in accordance with the invention, by increasing the FeO content of a known glass (glass 1) while incorporating colourants, as taught in the present invention, to maintain a neutral tint. Glass 1 is commercially available grey glass with a DSHT similar to its light transmission and a UV transmission about 40%. In glasses 2, 3 and 4 the amount of ferrous ion has been increased which, without compensating changes, would normally turn the glass blue and significantly reduce light transmission. The UV transmission has also been reduced which would normally introduce a greenness to the blue glass. The light transmission and neutrality of the glass have in fact been maintained by a balance of cobalt, neodymium, and selenium additions while controlling the ferrous/ferric ratio.

Selenium introduces a pink component to the colour of the glass thus complementing any blue in the glass to produce a more neutral colour. However, selenium also has colourless forms in oxidised glasses whilst reduced glasses are assumed to contain brown or colourless polyselenides. The oxidation/reduction of the glass must therefore be carefully controlled to retain selenium in the coloured pink form.

Selenium retention is at a maximum at about 20% ferrous/ferric ratio and is significantly reduced below 10% ferrous/ferric or above 40% ferrous/ferric. In glasses using selenium as a neutralising agent the ferrous/ferric ratio should

be between 10 and 40% for the best efficiency of retaining selenium in the coloured form.

Although cobalt in itself colours glass blue, it is useful as a colour neutralising agent because its absorptions are in the red end of the visible spectrum and can therefore be useful in counteracting the effect of reduced iron absorption in the infra red at 1050 nm.

Neodymium oxide is also useful in a similar way but is a better neutraliser than cobalt since it is dichroic and produces a blue and pink colouration depending on the kind of light in which it is viewed. However, neodymium oxide is expensive and cobalt in combination with selenium is preferred as a neutralising agent.

For glasses with a DSHT at least 7% points lower than the visible light transmission and a UV transmission of less than 25% in 4 mm path length, the following combination of additives is required.

Total iron expressed as  $\text{Fe}_2\text{O}_3$  in the range 0.25-1.75%, usually 0.25-1.25%.

The minimum FeO content to provide the necessary DSHT varies with optical density according to the equation

$$\% \text{ FeO} \geq 0.007 + \frac{(\text{optical density} - 0.036)}{2.3}$$

where optical density =  $\log_{10} T/100$

where T is the visible light transmission in percent for 4 mm glass.

This roughly equates to:-

Light Transmission	Minimum FeO Content
80%	0.033%
70%	0.058%
60%	0.087%
50%	0.122%
40%	0.153%
30%	0.218%

Ultraviolet absorption will be provided by iron oxide in the  $\text{Fe}^{3+}$  state, optionally supplemented by  $\text{V}_2\text{O}_5$  and/or,  $\text{CeO}_2$  and/or  $\text{TiO}_2$ . For most tints, a UV transmission of less than 25% is met simply by ferric iron. Where the ferric iron is less than 0.3% expressed as  $\text{Fe}_2\text{O}_3$ , UV transmission may be reduced below 25% by additions of:-

0.1 - 1.0  $\text{CeO}_2$  (if vanadium is absent)

0.05 - 0.2  $\text{V}_2\text{O}_5$  (if cerium is absent)

Many of the glasses contain at least 0.3% ferric iron expressed as  $\text{Fe}_2\text{O}_3$  and in addition have quantities of  $\text{CeO}_2$  and  $\text{V}_2\text{O}_5$  to provide enhanced UV protection.

Preferably the DSHT shall be at least 10% points lower than the visible light transmission; the minimum FeO content of the glass to meet this preferred condition is given by

$$\% \text{FeO} \geq 0.012 + \frac{(\text{optical density} - 0.036)}{1.84}$$

This roughly equates to:

Light Transmission	Minimum FeO Content
80%	0.045%
70%	0.076%
60%	0.113%
50%	0.156%
40%	0.208%
30%	0.276%

For the most neutral tints the ferrous/ferric ratio shall not be less than 10%.

A required tint may be achieved by adding one or more of Se,  $\text{Co}_3\text{O}_4$ ,  $\text{Nd}_2\text{O}_3$ ,  $\text{NiO}$  or  $\text{MnO}$ . The quantities of colourant and the colourant chosen to decolourise depends on the depth of tint required and the following guide lines are given.

Se up to 50 ppm chemical Se retained  
 $\text{Co}_3\text{O}_4$  up to 200 ppm  
 $\text{Nd}_2\text{O}_3$  up to 2.5%

Nickel oxide may be added as a colour neutralising agent but it is preferably limited to a maximum of 200 ppm to reduce the possibility of nickel sulphide inclusions which can shatter the glass.

Manganese oxide may also be added to the glass to provide pinkness but it is preferably limited to a maximum of 1% by weight

because of the danger of colour changes caused by solarisation. Similarly, cerium and vanadium oxide ultra violet absorbers in the same glass are preferably avoided because of the possibility of colour changes by solarisation.

Other components which may be present in glasses in accordance with the invention include copper oxide,  $\text{CuO}$  typically in an amount up to 0.1% by weight, which in certain conditions may reduce solar heat transmission, and chromium oxide,  $\text{Cr}_2\text{O}_3$ , typically in an amount up to 50 ppm, for colour modification.

The glasses in accordance with the invention are useful for both architectural and automotive purposes, and the invention also provides windows composed of glass in accordance with the invention. The automotive windows may be not only windscreens, but also the remaining windows of a car. These can eg include rear side windows with visible light transmissions as low as 30% and a rear screen as low as 50%.

The following examples except Example 1 (which is for comparison) illustrate but do not limit the invention. In the Examples, all parts and percentages are by weight and:.

- (a)  $\text{Fe}_2\text{O}_3$ ,  $\text{FeO}$ ,  $\text{Nd}_2\text{O}_3$ ,  $\text{CeO}_2$ ,  $\text{TiO}_2$ ,  $\text{V}_2\text{O}_5$ ,  $\text{SnO}$  and  $\text{MnO}_2$  are expressed in percent;  $\text{Se}$ ,  $\text{Co}_3\text{O}_4$  and  $\text{NiO}$  are expressed in parts per million.
- (b) total iron is expressed as if all iron present were present as ferric oxide.
- (c) percentage of total iron as  $\text{Fe}^{2+}$  is calculated from the spectral curve of the glass using the equation:-



$$\%Fe^{2+} = \frac{115.2 (OD_{1000} - 0.036)}{t \times Fe_2O_3}$$

where  $OD_{1000}$  = optical density of the glass at 1000 nm wavelength

t = glass thickness in millimetres

$Fe_2O_3$  = percentage total iron, expressed as  $Fe_2O_3$ , in the glass

(d) the FeO content is calculated from the equation

$$\%FeO = \frac{\%Fe^{2+}}{100} \times Fe_2O_3 \times \frac{143.7}{159.7}$$

$Fe_2O_3$  = percentage total iron, expressed as  $Fe_2O_3$ , in the glass

(143.7 being the molecular weight of 2 x FeO and

159.7 being the molecular weight of  $Fe_2O_3$ ).

#### Examples

#### CHEMICAL ADDITIVES

	Total iron as $Fe_2O_3$	% Total iron as FeO	% of total iron as $Fe^{2+}$	Se	$Co_3O_4$	$Nd_2O_3$	$CeO_2$	$TiO_2$	$V_2O_5$	Other
	%	%								
1 Solargrey	0.25	0.043	18%	11	41	-	-	-	-	-
2	0.35	0.082	26%	3	32	0.15	0.4	-	-	-
3	0.38	0.078	23%	5	32	-	0.34	-	-	-
4	0.38	0.099	29%	2	32	-	0.4	-	-	-
5	0.25	0.038	17%	9	-	-	-	-	0.1	-
6	0.25	0.065	29%	3	-	-	-	-	0.1	-
7	0.34	0.098	32%	<2	32	-	0.4	-	-	-
8	0.45	0.030	7.5%	24	18	-	0.4	-	-	-
9	0.45	0.093	23%	5	38	-	0.4	-	-	-
10	0.45	0.142	35%	<2	38	-	0.4	-	-	-
11	0.45	0.154	38%	<2	38	-	0.4	-	-	-
12	0.45	0.117	29%	<2	-	0.2	0.4	-	-	-
13	0.45	0.126	31%	<2	-	0.5	0.4	-	-	-

	Total iron as Fe <sub>2</sub> O <sub>3</sub>	FeO	% of total iron as Fe <sup>2+</sup>	Se	Co <sub>3</sub> O <sub>4</sub>	Nd <sub>2</sub> O <sub>3</sub>	CeO <sub>2</sub>	TiO <sub>2</sub>	V <sub>2</sub> O <sub>5</sub>	Other
	%	%								
14	0.45	0.122	30%	<2	-	0.3	0.4	-	-	-
15	0.45	0.142	35%	<2	38	-	0.5	0.25	-	-
16	0.45	0.134	33%	<2	-	-	0.4	0.2	-	-
17	0.45	0.142	35%	<2	-	0.3	0.4	-	-	NiO
18	0.45	0.146	36%	5	-	0.3	0.4	-	-	100ppm
19	0.45	0.130	32%	16	25	-	0.4	-	-	-
20	0.4	0.104	29%	8	30	-	0.4	-	-	-
21	0.45	0.150	37%	10	38	-	0.4	-	-	SnO
22	0.4	0.097	27%	4	18	-	-	-	-	1.0
23	0.6	0.124	23%	<2	20	-	0.2	-	0.1	-
24	0.7	0.088	14%	<2	-	0.7	1.0	-	-	-
25	0.7	0.157	25%	7	38	-	-	-	-	-
26	0.77	0.090	13%	-	-	0.5	1.0	0.5	-	-
27	0.5	0.122	27%	12	76	-	0.1	-	-	-
28	0.45	0.146	36%	7	80	-	-	-	-	-
29	0.675	0.213	35%	9	57	-	-	-	-	-
30	1.23	0.443	40%	11	104	-	-	-	-	-
31	0.675	0.182	30%	14	57	-	-	-	-	-
32	0.7	0.227	36%	20	80	-	-	-	-	-
33	0.7	0.227	36%	20	120	-	-	-	-	-
34	0.7	0.258	41%	16	120	-	-	-	-	-
35	0.675	0.249	41%	3	57	-	0.2	1.0	-	-
36	0.9	0.300	37%	10	20	-	-	-	-	-
37	0.7	0.290	46%	11	Zero	2.0	-	-	-	-
38	0.8	0.209	29%	24	81	-	-	-	-	-
39	1.0	0.225	25%	14	150	-	-	-	-	-
40	0.6	0.086	16%	-	20	-	0.4	-	-	MnO <sub>2</sub>
41	0.6	0.162	30%	<2	20	0.1	-	-	-	1.0 <sup>2</sup>
42	0.7	0.258	41%	15	120	-	-	-	-	-
43	1.0	0.315	35%	9	20	-	-	-	-	NiO
44	1.23	0.277	25%	12	104	-	-	-	-	275ppm
45	1.40	0.252	20%	10	104	-	-	-	-	-

TRANSMISSION COLOUR

	LT	DSHT	UVT	a*	b*	Dominant Colour wavelength $\lambda_D$	Purity
1 Solargrey	70	70	40	-0.3	1.1	454	2.1%
2	69	61	23	-1.9	-1.4	485	2.7%
3	68	59	21	-0.8	+2.0	570	1.2%
4	68	56	22	-2.4	-0.6	489	2.2%
5	82	75	17	-2.2	+4.9	569	3.9%
6	80	69	23	-4.5	+4.5	558	3.1%
7	73	59	25	-3.5	-3.2	486	4.9%
8	80	72	23	-1.4	+1.6	547	0.5%
9	64	55	20	-1.4	+1.5	547	0.6%
10	64	48	22	-3.7	-1.9	488	4.0%
11	64	46	23	-4.9	-3.8	487	6.1%
12	72	54	20	-3.0	+2.2	530	0.9%
13	71	55	22	-4.0	-1.6	489	3.9%
14	73	56	22	-3.4	+0.6	495	1.7%
15	64	47	17	-4.3	-0.6	492	3.1%
16	74	52	20	-4.6	+3.0	534	1.6%
17	67	49	22	-4.5	+2.3	515	1.3%
18	65	47	18	-2.3	+3.7	564	2.8%
19	57	46	15	+1.0	+9.0	553	3.0%
20	64	54	20	-0.3	+3.8	576	3.4%
21	60	47	19	-1.9	+2.1	553	1.1%
22	69	57	18	-4.7	+4.3	553	3.0%
23	71	54	22	-3.8	+1.0	499	1.5%
24	67	58	11	-2.0	+3.7	566	2.7%
25	61	45	21	-4.4	+0.5	493	3.3%
26	73	60	8	-5.7	+3.9	536	2.2%
27	48	41	18	-0.8	+1.1	552	0.4%
28	51	42	22	-3.8	-2.1	488	4.5%
29	50	35	20	-4.0	-0.2	493	2.8%
30	30	16	9	-8.8	-4.1	489	10.3%
31	49	36	17	-2.5	+2.5	553	1.7%
32	39	29	13	-0.7	+4.9	574	5.6%
33	33	25	12	-1.0	+0.9	511	0.3%
34	37	27	16	-3.3	-4.3	484	6.9%
35	54	36	15	-7.4	-1.3	492	5.5%
36	51	29	16	-6.6	+3.3	521	2.1%
37	40	28	15	-3.5	-3.4	486	6.0%
38	36	27	9	+0.6	+8.4	578	10.9%
39	33	26		-3.9	-5.0	485	8.3%
40	75	60	13	-6.0	+4.4	543	2.7%
41	69	49	23	-5.8	-2.5	489	5.4%
42	34	25	17	-4.0	+1.4	504	1.7%
43	52	28	15	-9.5	+0.3	496	5.3%
44	36	24	7	-5.7	+0.4	496	3.6%
45	39	27	5	-7.4	+0.1	496	4.7%

Several of the examples given are suitable as high performance architectural glasses for buildings because of their superb infra-red and UV absorbance combined with neutrality of colour. The properties of architectural glasses are often quoted in 6 mm path length and the Total Solar Heat Transmission (TSHT) is quoted in addition to the DSHT. Some examples particularly suitable for architectural use are as follows:-

<u>Example</u>	<u>Transmission in 6 mm path length</u>			
	<u>Light Transmission</u>	<u>DSHT</u>	<u>TSHT</u>	<u>UVT</u>
3	58%	48%	60%	15%
7	65%	48%	60%	20%
11	55%	36%	51%	17%
13	63%	44%	57%	16%
14	65%	44%	57%	16%
21	63%	44%	57%	16%

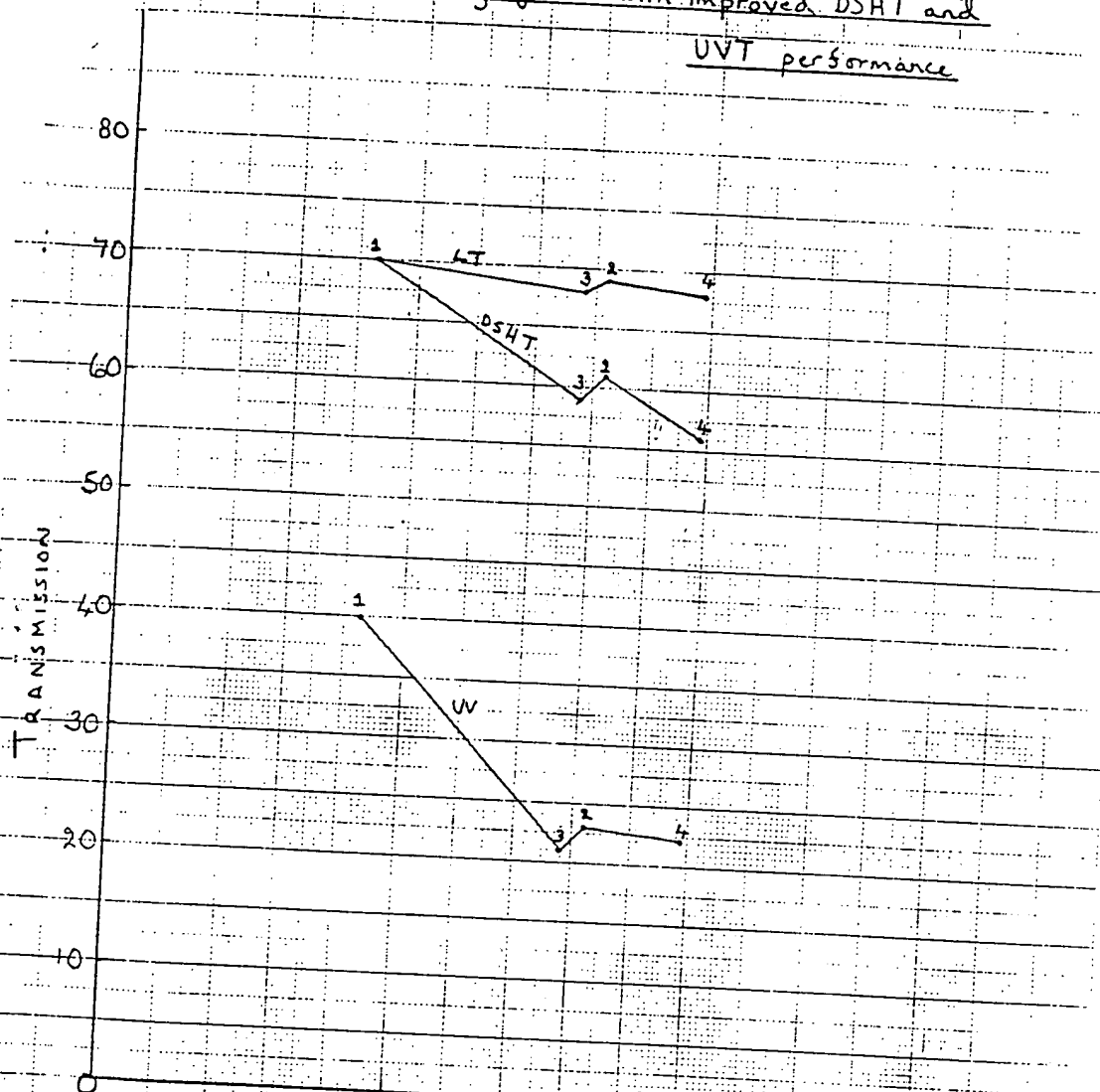
Claims

1. An IR and UV absorbing soda lime silica glass of a neutral tint as herein defined having a ferrous iron content  
$$\% \text{ by weight FeO} \geq 0.007 + \frac{(\text{Optical density} - 0.036)}{2.3}$$
and a total iron content expressed as  $\text{Fe}_2\text{O}_3$  in the range 0.25 - 1.75% by weight,  
the glass having been tinted to a neutral colour by one or more of  $\text{Se}$ ,  $\text{Co}_3\text{O}_4$ ,  $\text{Nd}_2\text{O}_3$ ,  $\text{NiO}$  and  $\text{MnO}$ ,  
the glass having, in a 4 mm thickness, a visible light transmission of at least 32%, a UV transmission preferably less than 25%, and a direct solar heat transmission at least 7 percentage points below the visible light transmission, and having a dominant wavelength preferably less than 570 nm, provided that, when the dominant wavelength is above 570 nm and the visible light transmission is greater than 60%, the colour purity is not greater than 4,  
and when Se is present, at least one other colourant selected from  $\text{Co}_3\text{O}_4$ ,  $\text{Nd}_2\text{O}_3$ ,  $\text{NiO}$  and  $\text{MnO}$  is present in an amount by weight at least 1.5 times the amount of Se present.
2. An IR and UV absorbing glass according to claim 1 having, in 4 mm thickness, a direct solar heat transmission at least 10 percentage points below its visible light transmission.

3. An IR and UV absorbing glass according to claim 1 or claim 2 having, in 4 mm thickness, a dominant wavelength above 570 nm, a visible light transmission greater than 60% and a colour purity less than 2.
4. An IR and UV absorbing glass according to any of the preceding claims containing Se and at least one other colourant selected from  $\text{Co}_3\text{O}_4$ ,  $\text{Nd}_2\text{O}_3$ , NiO and MnO in an amount by weight at least twice the amount of Se present.
5. An IR and UV absorbing glass according to claim 4 having a visible light transmission greater than 60% and an Se content of less than 5 parts per million by weight.
6. An IR and UV absorbing glass according to the preceding claims containing 0.1 to 1.0% by weight  $\text{CeO}_2$ .
7. An IR and UV absorbing glass according to any of claims 1 to 5 containing 0.05 to 0.2% by weight  $\text{V}_2\text{O}_5$ .
8. An IR and UV absorbing glass according to any of the preceding claims containing up to 50 ppm by weight Se.
9. An IR and UV absorbing glass according to any of the preceding claims containing up to 200 ppm by weight  $\text{Co}_3\text{O}_4$ .

10. An IR and UV absorbing glass according to any of the preceding claims containing up to 2.5% by weight  $\text{Nd}_2\text{O}_3$ .
11. An IR and UV absorbing glass according to any of the preceding claims containing up to 200 ppm by weight  $\text{NiO}$ .
12. An IR and UV absorbing glass according to any of the preceding claims containing up to 1% by weight  $\text{MnO}$ .
13. An IR and UV absorbing glass having a neutral tint substantially as hereinbefore described in any one of the Examples.
14. An IR and UV absorbing glass according to any of the preceding claims in sheet form.
15. A window composed of glass according to any of the preceding claims.
16. An automotive window composed of glass according to any of the preceding claims.

Figure 1 Grey glasses with improved DSHT and UVT performance



Glass	% FeO									
	LT	DSHT	UV	a*	b*	Total FeO <sub>2</sub>	FeO	Se	C <sub>2</sub> O <sub>3</sub>	Ni <sub>2</sub> O <sub>3</sub>
1	70	70	40	-0.3	-1.1	0.35	0.013	71	41	
2	68	61	23	-1.9	-1.4	0.35	0.082	3	32	0.75
3	68	59	21	-0.8	-2.0	0.38	0.078	5	32	
4	68	56	20	-2.4	-0.6	0.38	0.099	2	32	



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